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RECLAMATION

Planning - Practice - Results

PROCEEDINGS OF
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CLRA CANADIAN LAND RECLAMATION ASSOCIATION

REVEGETATION AND RECLAMATION OF SANDY REGOSOLS

- A Preliminary Assessment -

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Revegetation and Reclamation of Sandy Regosols
- A Preliminary Assessment -

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A B S T R A C T

The paper presented here documents the preliminary results of drill seeding native and introduced grass and legume species into a plot that has been fertilized by deep banding. A mulch treatment was simulated by killing existing surface vegetation with glyphosphate (trade named "Roundup"). The study goal was to determine which test species grew more favorably on an amended sandy regosol in southeastern Alberta and to determine subjectively the effectiveness of deep banding fertilizer.

Though all seeded species germinated in late fall (1982) and early spring (1983) early summer (1983) grass growth assessment indicated that russian wild ryegrass (Elymus junceus var. "Swift"), two varieties of crested wheatgrass (Agropyron desertorum var. "Nordan" and Agropyron cristatum var. "Fairway") and slender wheatgrass (Agropyron trachycaulum var. "Revenue") produced the most favorable growth. Alfalfa (Medicago sativa var. "Drylander") produced a continuous steady germination and growth rate ranging mostly from 75%-95% despite rabbit and deer browsing. Hard fescue (Festuca ovina var. "Durar"), slender wheatgrass and the two varieties of crested wheatgrass were the only grasses which grew with alfalfa. However, alfalfa heavily dominated the grass legume mix. Cicer milkvetch (Astragalus cicer var. "Oxley"), proved a better legume for allowing a greater percentage of grass growth in a legume-grass mix. Six grass species -- russian wildrye (Elymus junceus var. "Swift"), hard fescue, slender wheatgrass, the two crested wheatgrass varieties and northern wheatgrass (Agropyron dasytachum var. "Elbee") grew well with cicer milkvetch.

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I INTRODUCTION

Many sandy areas occur throughout southern Alberta. When these sandy soils are disturbed, vegetation that has been damaged or eliminated is difficult to re-establish. The factors wind erosion, low moisture availability combined with high soil surface temperatures and low nutrient status usually preclude successful regrowth or revegetation efforts on any disturbed sandy sites. Because sandy soils are difficult to revegetate, the study outlined below was developed to determine which grasses and legumes would grow most favorably on a sandy regosol that had been amended by deep banding specifically chosen fertilizers. The study was also to subjectively assess the effectiveness of deep banding different fertilizer applications.

II SITE DESCRIPTION

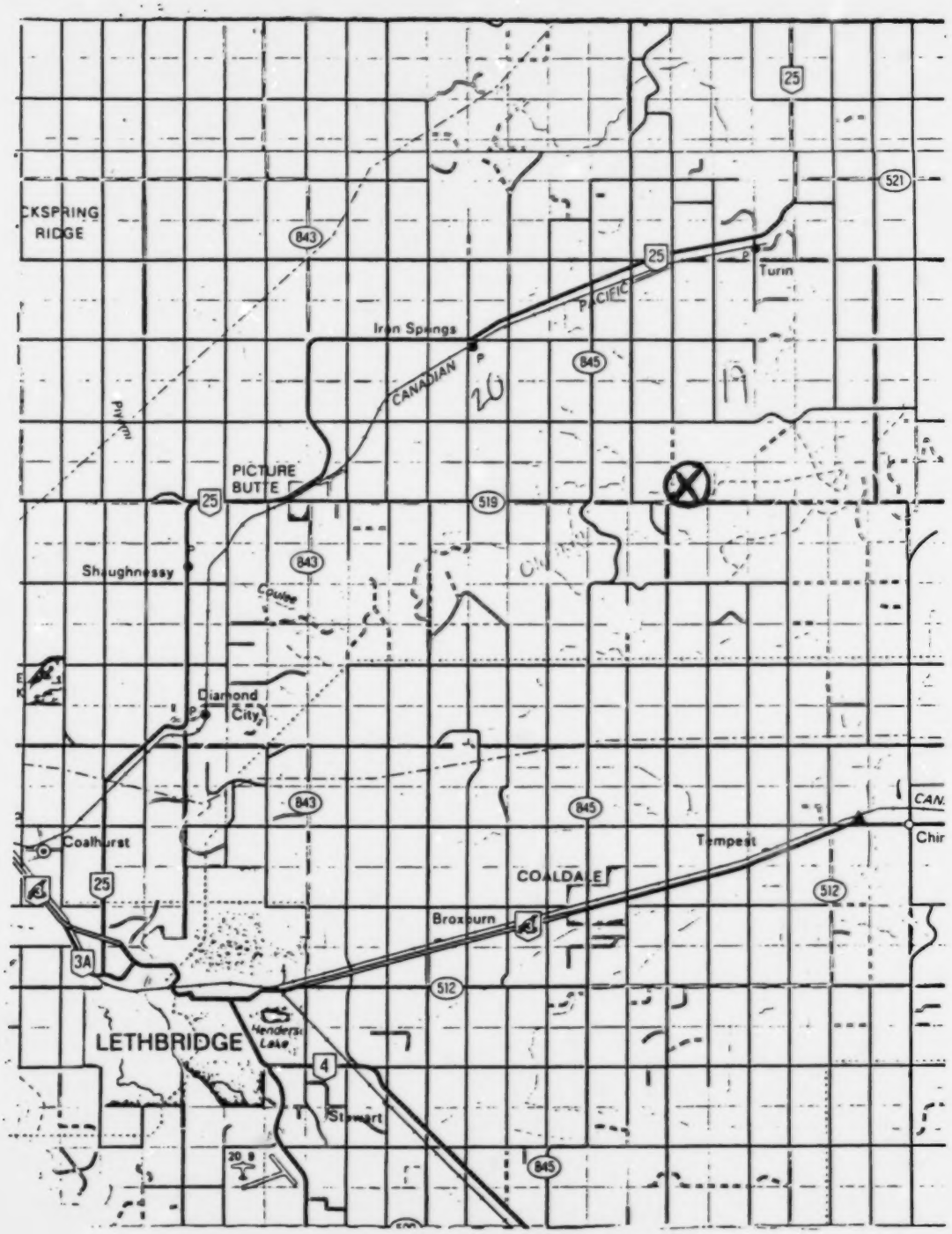
A. Location

The study location chosen is a mile and half north of the Old Man River at SE 5-11-19-W4. The surrounding area is shortgrass prairie which supports cattle grazing for about 2 weeks to one month of the year depending on vegetation success. The exact plot site is slightly depressional with a moderate downward northeast slope of about 5%. Figure (1) shows a map location of the site.

B. Soil

The soil is classed as an Orthic Brown Regosol. A three to four inch fine gravel lens occurs fifteen inches deep. Surrounding gravel ridges and exposed sandy outcrops are scattered throughout the area. The terrain has a gently rolling relief.

Figure 1


CKSPRING
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843
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521
Turin
PACIFIC
Iron Springs
CANADIAN
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PICTURE
BUTTE
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Shaughnessy
Coulee
Diamond
City
Coalhurst
COALDALE
Tempest
512
Broxburn
3A
LETHBRIDGE
Henderson
Lake
4
Stewart
20

C. Vegetation

The site is typically a Stipa-Bouteloua native grassland range type.

Speargrass (Stipa comata), bluegrama (Bouteloua gracilis), sandgrass or sandreed grass (Calamovilfa longifolia) and june grass (Koeleria cristata) are the dominant grasses. Prickly pear (Opuntia polyacantha) and rose (Rosa woodsii) are also common to the site. Other native vegetation found on site are listed in Table (1).

III SITE PREPARATION AND DESIGN

1. Plot Layout

Three replications of eight different grasses and two legumes with five different fertilizer combinations were established. The plot layout is shown in Figure (2).

2. Herbicide Treatment

Prior to fertilizing and seeding, the plot area was sprayed May 14 and 18, 1982 with glyphosphate (tradenamed "Roundup"). The herbicide application was attempted to eliminate existing growing vegetation and yet retain root material to simulate a crimped mulch straw treatment. A heavy dose of 1 part herbicide and three parts water was applied by a six foot boom sprayer mounted on a bicycle wheel and a hand held stainless steel tank application.

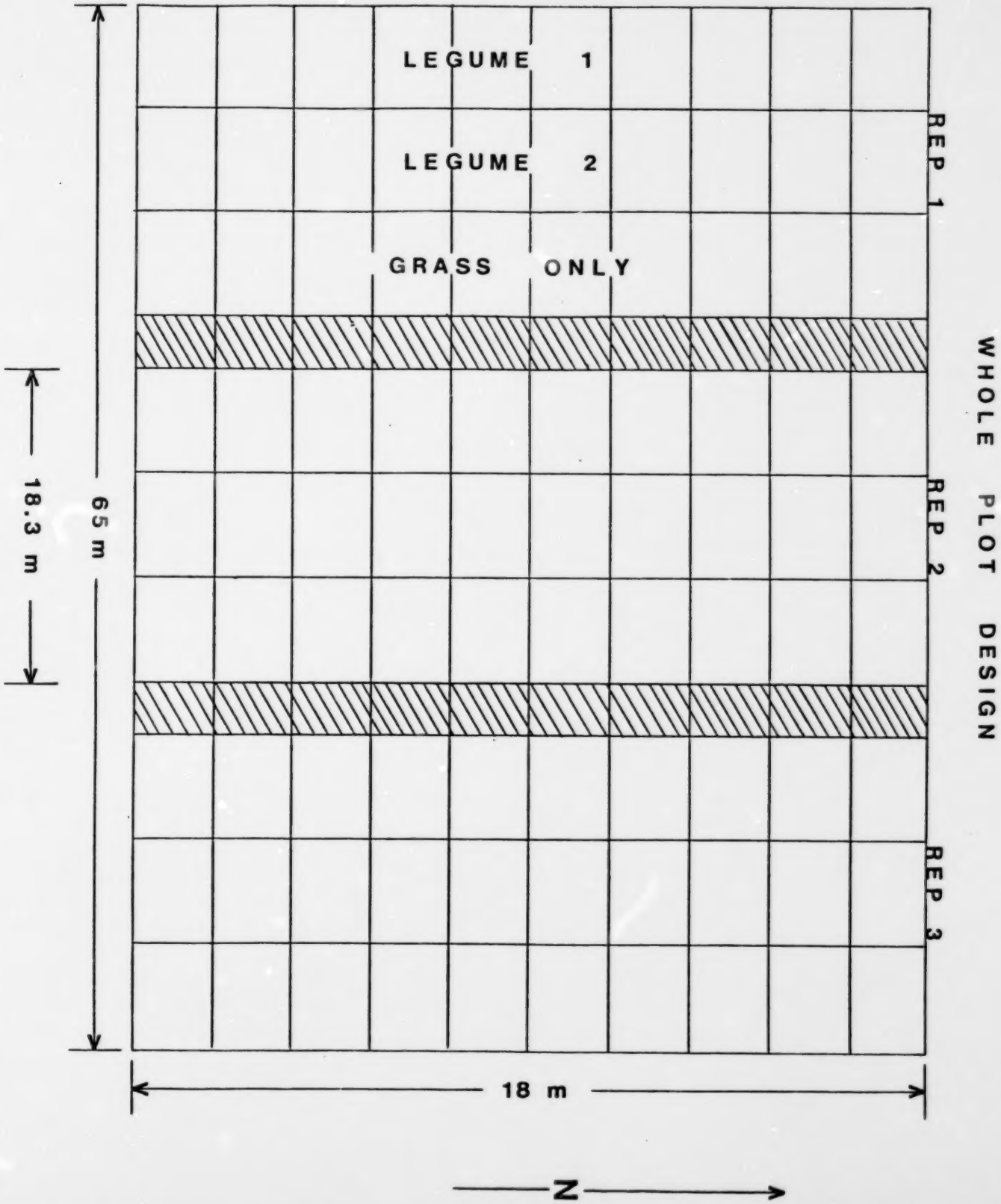
3. Fertilizer Application

The bulk of the fertilizers used was deep banded to a depth of six inches on May 17, 1982. The deep banding occurred seven inches to the side of the seed row 1 day before seeding. A small surface application was also applied prior to the drill seeding operation. The five fertilizers were applied randomly on each plot. Replicate one is illustrated in Figure (3).

Table 1

NATIVE VEGETATION

Scientific Name	Common Name
Poa secunda	Sandberg Bluegrass
Agropyron smithii	Western Wheatgrass
Carex filifolia	Sedge
Artemisia frigida	Pasture sagewort
Oxytropis sericea	Early yellow Loco-weed
Lithospernum incisum	Narrow-leaved puccoon
Antennaria dimorpha	Cushion everlasting
Erigeron caespitosus	Tufted fleabane
Liatrus punctata	Dotted blazingstar
Penstemon albidus	White beardtongue
Lygodesmia juncea	Skeletonweed
Chrysopsis villosa	Hairy golden-aster
Lomatium macrocarpum	Long-fruited parsley
Opuntia polyacantha	Prickly-pear



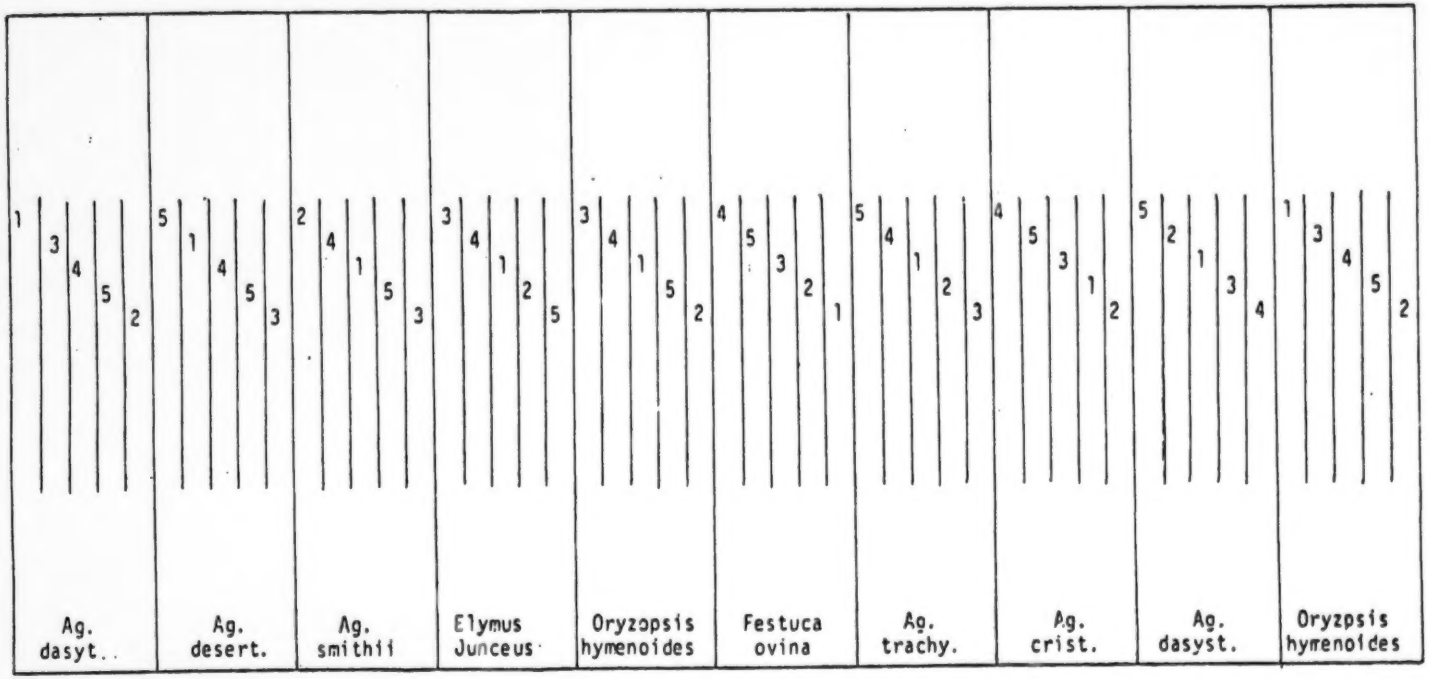
WHOLE PLOT DESIGN

Figure 3

REPLICATE NO. 1

SHOWING GRASS AND FERTILIZER

(LEGUME NOT SHOWN)



The fertilizers are represented by the numbers above and are as follows;

1 = 0-45-0 (triple superphosphate)
2 = 46-0-0 (urea)
3 = 32-0-0 (sulphur coated urea)
4 = 46-0-0 + 0-45-0 (urea + triple superphosphate)
5 = 32-0-0 + 0-45-0 (sulphur coated urea + triple superphosphate)

Figure (4) illustrates fertilizer placement spacing prior to the test and spacer grass seeding. Table (2) illustrates the fertilizers and application rates used.

4. Drill Seeding

A forage plot drill seeder developed by Agriculture Canada was utilized tp plant both the grasses and legumes on May 19, 1982. The seeder has a fixed depth gauge set at a 1/2 inch and a set of doub e wheel packers to firm the soil and help cover the seed. The machine is 1.8 meters wide and each seed row is set 18 cm apart. The test grass species were spaced every second seed box or 36 cm apart and a spacer grass (Agropyron cristatum - "Fairway" variety) was placed between every test grass to help separate fertilizer effects. Figure (5) illustrates the replicate configuration.

The seeding rate was based on the average number of seeds per pound required to plant 60 seeds per foot or 200 seeds per meter of row. The rates or grams per package established for each 18.3 meter species row is shown in Table (3). Two grasses were repeated for each replicate because two grasses that were originally designated for planting, Andropogon scoparius (little bluestem) and Calamovilfa longifolia (prairie sandreed), were too feathery to pass through the drill.

IV DATA COLLECTION

1) Weather Data

A tipping bucket rain gauge and a thermohygrograph (with humidity and temperature recordings), loaned by Environment Canada, each with a seven day recording capacity were set up on site to record temperature, humidity and rainfall. The humidity charts were abandoned halfway through the summer of 1982 because field mice destroyed the sensor hairs. Temperatures and rain results are shown in Table (4) for 1982 and 1983.

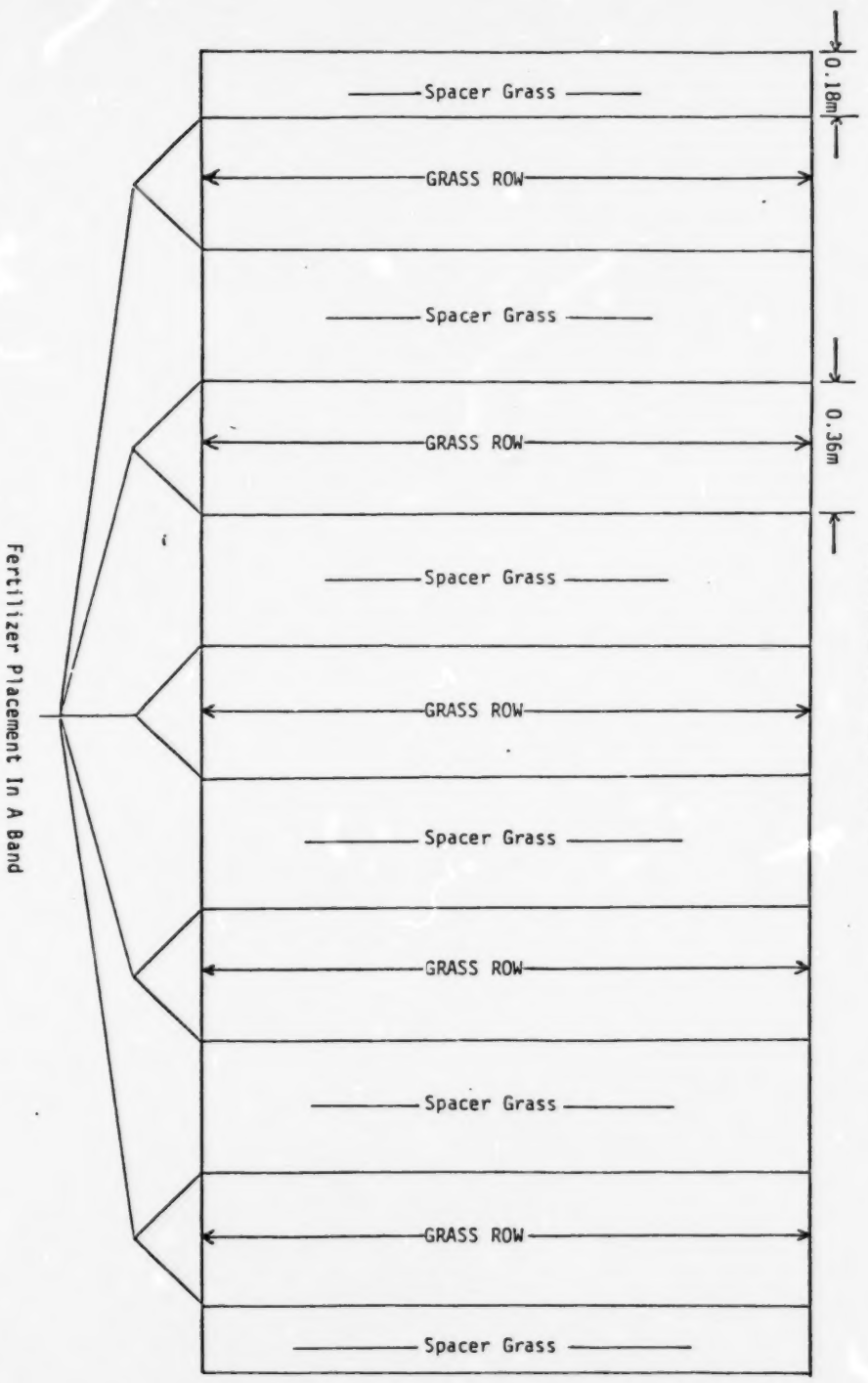


Figure 4
PLOT EXAMPLE
OF
FERTILIZER AND GRASS SPACING

Figure 5

Randomized Species Placement on Whole Plot

REP 1				REP 2				REP 3			
L_1	L_2		L_0	L_1	L_2		L_0	L_1	L_2		L_0
Agropyron	dasystachyum ALFALFA		- Elbee	Agropyron	trachycaulum		- Revenue	Oryzopsis	hymenoides		
Agropyron	desertorum		- Nordan	Elymus	junceus		- Swift	Agropyron	trachycaulum		- Revenue
Agropyron	smithii		- Rosana	Oryzopsis	hymenoides			Agropyron	desertorum		- Nordan
Elymus	junceus		- Swift	Agropyron	dasystachyum		- Elbee	Agropyron	smithii		- Rosana
Oryzopsis	hymenoides			Agropyron	cristatum		- Fairway	Festuca	ovina		- Durar
Festuca	ovina		- Durar	Agropyron	desertorum		- Nordan	Elymus	junceus		- Swift
Agropyron	trachycaulum		- Revenue	Agropyron	smithii		- Rosana	Agropyron	cristatum		- Fairway
Agropyron	cristatum		- Fairway	Festuca	ovina		- Durar	Agropyron	dasystachyum		- Elbee
Agropyron	dasystachyum		- Elbee	Agropyron	trachycaulum		- Revenue	Oryzopsis	hymenoides		
Oryzopsis	hymenoides			Elymus	junceus		- Swift	Agropyron	smithii		- Rosana

LEGEND: L_1 = Medicago sativa L. - Rangelander (Alfalfa)

L_2 = Astragalus cicer L. - Oxley (Cicer milk-vetch)

L_0 = Grass only

Grasses and legumes were planted in same row and crested wheatgrass was planted between experiment rows to eliminate edge effects

TABLE 3

PLANTING RATES FOR
GRASSES & LEGUMES - Bases on 200 seeds/Meter of Row

	Seeds/lb	Package weight of seed used/6.1 m. Row (g)	% Pure Live Seed
Agropyron trachycaulum	159,000	3.5	86.2
Agropyron smithii	110,000	5	
Agropyron desertorum	175,000	3	
Agropyron dasystachum	154,000	3.5	87.0
Elymus junceus	175,000	3	
Festuca ovina	680,000	1.5	79.0
Calamovilfa longifolia	273,000	3	
Oryzopsis hymenoides	141,000	4	
Medicago sativa	200,000	2	
Astragalus cicer	130,000	4.5 (coated seed)	

TABLE 4

PRECIPITATION AND TEMPERATURE RECORDINGS
FOR 1982/83

MONTH	PRECIP. (mm)	TEMP. (^{o}C)			
		Mean Low	Mean High	Low	High
		1982			
JUNE	55.9	6.8	35.05	1	42
JULY	97.79	8.5	25.4	3	33
AUGUST	98.04	7.3	25.4	3	32
SEPTEMBER	6.10	2.6	19.6	-4	30
		1983			
MAY	22.86	3.5	18.5	-8	30
JUNE	1.27	9.3	22.4	3	30

2) Soil Testing Results - Sample Analysis *

A preliminary soil test prior to fertilization (Table 5) illustrates the various values before fertilization occurred. The results of an example soil test are shown in Table (6) for August and October of 1982 and May of 1983. The sample is taken from Plot 2 - replicate two for all three sets of analysis.

The analysis shows the progressive nutrient changes in the top thirty six inches over time.

3) Germination Test

A simple germination test was conducted for all grasses grown on the test site. Ten seeds for each grass were placed inside a water saturated paper towel. These towels were in turn placed inside a plastic bag. The seeds were assessed every day to determine germination success.

4) Vegetation Results

The vegetative results are taken mostly from replicate two and once from replicate one because replicates one and three did not produce satisfactory results. Future sampling will incorporate what results are able to be obtained from replicate one. Replicate three produced no usable results.

Three sets of results are illustrated for grass and legume values. Table (7) indicates the fall 1982 results. Table (8) indicates the spring 1983 results. A twenty five centimeter length was used for each row counted to obtain the percentage estimates. These numbers were an attempt to obtain a stem count or percent emergence for the test grasses grown.

The values shown in Table (9) are a visual estimate of the percentage legume and/or grass occupying each row in a plot. The results are noted for each 6.1 meter length which

*Soil test done by Soil and Feed Testing Lab, Alberta Agriculture

TABLE 5

EXAMPLE SOIL ANALYSIS - PRIOR TO FERTILIZING

Sample	pH	Electrical Conductivity ($S.M.^{-1}$)	Available Plant Nutrients (ppm) NO_3	NH_4	P	K	Cation Exchange Capacity (meq/100g) T.E.C.	Ca*	Mg	Na	K	Ca	%O.M	Texture %Sand	%Silt	%Clay
0-6"	8.0	0.2	0.5	2.4	4.5	100	6.6	52.4	4.0	0.9	1.2	0.5	1.7	88	8	4
0-12"	8.0	0.2	1.0	2.5	2.0	72	4.9	60.6	1.7	0.3	0.4	2.5	1.1	90	8	2
0-6"	8.0	0.2	0.5	3.7	6.0	143	6.6	37.2	2.7	0.9	0.7	2.3	1.7	82	12	6
6-12"	8.1	0.2	0.5	2.7	6.5	202	5.5	57.4	2.2	0.3	0.5	2.5	1.5	88	10	2

*Free Lime and Ca

TABLE 6

SOIL SAMPLES - EXAMPLE ANALYSIS

Sample	pH	Electrical Conductivity ($S.M.^{-1}$)	Plant Nutrients (ppm) NO_3	NH_4	P	K	S	Na
A THREE MONTHS AFTER FERTILIZATION								
1 0-6"	8.1	0.5	35	9.0	4.5	131	4.4	30
2 6-12"	8.1	0.4	17.5	9.5	2.0	133.5	4.2	40.5
3 12-24"	8.4	0.4	17.5	11.6	0.5	72.0		44.
4 24-36"	8.4	0.3	13.0	7.8	0.5	58		34.5
B FIVE MONTHS AFTER FERTILIZATION								
1 0-6"	8.4	0.5	17	6.5	264.5	655	2.4	60.5
2 6-12"	8.5	0.5	28	0.5	170	76	3.2	76
3 12-24"	8.6	0.4	16.5	0	115.5	17		57
4 24-36"	8.7	0.4	14	0	117.5	55.5		55.5
C ONE YEAR AFTER FERTILIZATION								
1 0-6"	8.1	0.2	4.39	7.99	5	113	1.7	5
2 6-12"	8.1	0.3	3.74	13.0	0	77	1.8	5
3 12-24"	8.3	0.2	3.64	9.91	0	48		5
4 24-36"	8.4	0.2	3.38	5.61	0	54		6

TABLE 7

PERCENT GRASS EMERGENCE FOR OCTOBER 1982*

Test Grass	With Alfalfa	With Cicer Milkvetch	Grass Alone
Agropyron trachycaulum (slender wheatgrass-Revenue)	10.4	12.8	12.8
Elymus junceus (Russian wildrye-swift)	9.6	10.8	10.8
Oryzopsis hymenoides (Indian ricegrass)	3.6	2.8	8.8
Agropyron dasystachum (Northern wheatgrass-Elbee)	13.6	18.0	30.4
Agropyron cristatum (Crested wheatgrass-Fairway)	26.0	8.8	16.4
Agropryon desertorum (Crested wheatgrass-Nordan)	11.2	20.0	11.2
Agropyron smithii (Western wheatgrass-Rosana)	7.2	16.8	10.4
Festuca ovina (Sheep fescue-Durar)	8.0	7.6	3.6

*Stem count taken from a 25cm. length and percentages based on 50 planted seedlings per 25cm. length

TABLE 8

PERCENT GRASS EMERGENCE FOR MAY 1983*

Test Grass	With Alfalfa	With Cicer Milkvetch	Grass Alone
Agropyron trachycaulum (slender wheatgrass-Revenue)	22.8	23.6	20.4
Elymus junceus (Russian wildrye-swift)	7.2	13.2	4.8
Oryzopsis hymenoides (Indian ricegrass)	0.8	1.2	5.2
Agropyron dasystachum (Northern wheatgrass-Elbee)	10.8	11.6	13.6
Agropyron cristatum (Crested wheatgrass-Fairway)	24.0	3.6	16.4
Agropyron desertorum (Crested wheatgrass-Nordan)	18.4	8.4	21.6
Agropyron smithii (Western wheatgrass-Rosana)	13.6	8.0	7.6
Festuca ovina (Sheep fescue-Durar)	7.2	12.4	6.0

*Stem count taken from a 25cm. length and percentages based on 50 planted seedlings per 25cm. length.

TABLE 9

A VISUAL PERCENTAGE(*) ESTIMATE OF GRASS AND LEGUME GROWTH (TAKEN FROM REPS ONE AND TWO)

Test Grass	Alfalfa/Grass	Cicer Milkvetch/Grass	Grass Alone
Agropyron trachycaulum (slender wheatgrass-Revenue)	65/5	30/35	25
Elymus junceus (Russian wildrye-swift)	55/1	20/10	-
Oryzopsis hymenoides (Indian ricegrass)	65/0	45/0	-
Agropyron dasystachum (Northern wheatgrass-Elbee)	80/5	15/2	-
Agropyron cristatum (Crested wheatgrass-Fairway)	70/10	15/35	-
Agropyron desertorum (Crested wheatgrass-Nordan)	70/5	7/5	25
Agropyron smithii (Western wheatgrass-Rosana)	60/0	1/0	-
Festuca ovina (Sheep fescue-Durar)	80/0	60/10	-

*Number given represents percentage estimate the particular component occupies of each 6.1 meter row section.

represents the row measurement of alfalfa, cicer milkvetch and grass planted seeded respectively for each replicate. These last results were obtained the first week in July, 1983. Plots that are not shown are those plots for which no data was available or collected.

V DISCUSSION

a) Soil Results

The nutrient status indicates a downward movement of nitrogen. A large amount of nitrate and ammonium has accumulated or become available three months after fertilization. Nitrate accumulates further five months after fertilization. Such accumulation may be due to ammonium-nitrogen changing to nitrate-nitrogen and to a concentration of the surface applied nitrate being held just above the gravel lens level. Ammonium change to nitrate however would be dependent on an active soil micro-organism community (Nitrosomonas and Nitrobacter) which would likely be low in a sandy soil. The increased ammonium levels one year after fertilization is likely due to slow release sulphur coated urea. Potassium and Na rates are likely to fluctuate up and down as somewhat indicated because of the low anion levels and almost non-existent clay component which would bind these elements. The coarse soil texture would allow free water flow up and down as governed by evaporation and rainfall influences and thus allow free cation movement. After one year the nitrates seemed to have leached out and the ammonium is still showing a strong presence again probably because of a slow ammonium release through the sulphur coated urea.

b) Vegetation Results

Because no discernable growth difference occurred between the grasses relative to the type of fertilizer applied, the results for each test grass plot (containing 5 rows per plot) were lumped together.

1) Fall 1982

All grass species showed emergence by October, 1982. For grasses grown with alfalfa, fairway crested wheatgrass showed the highest success. Northern wheatgrass showed the next most promising results. Indian ricegrass showed the least success of the grasses grown with alfalfa.

For grasses grown with cicer milkvetch, nordan crested wheatgrass grew best followed closely by northern wheatgrass. Indian ricegrass also showed the poorest results with the vetch. The grasses grown without a legume showed northern wheatgrass to have much better emergence than the other grasses. Hard fescue grew the least for the grasses grown without a legume.

For fall emergence the two crested wheatgrass varieties thus seem to compete best with the hardy growing alfalfa. The less persistent vetch showed a slightly changed grass growth response by allowing northern wheatgrass to have a higher emergence probably because of the reduced legume competition. Northern wheatgrass growing alone seems to be an appropriate species for good fall emergence.

2) Spring 1983

All species showed some spring emergence.

Grasses grown with alfalfa showed fairway crested wheatgrass, slender wheatgrass and nordan crested wheatgrass respectively to be the most successful. Indian ricegrass showed virtually no emergence.

Grass response with cicer milkvetch showed slender wheatgrass to have the best emergence. Indian ricegrass emerged the least.

Grasses grown alone showed similar results to grasses grown with alfalfa. Nordan crested wheatgrass, slender wheatgrass and fairway crested wheatgrass respectively were the most successful species. Russian wildrye was the least successful grass for spring emergence.

The two crested wheatgrass varieties and slender wheatgrass are fast germinators and are known to have good persistence. Thus results shown for grass growth with alfalfa and grass growth alone are somewhat expected. Increased russian wildrye and hard fescue growth with cicer milkvetch over that with alfalfa seemed to be a result of shading by the vetch and possibly reduced moisture uptake by the vetch compared to alfalfa. Poor crested wheatgrass growth with the vetch was not expected.

3) Early Summer Results - July, 1983

For grasses grown with alfalfa, the legume completely dominated the plots. From the time alfalfa first germinated in 1982, the legume showed excellent emergence and growth endurance throughout the growing season despite deer and rabbit browsing. Alfalfa has a high water demand and thus, along with the high soil surface temperatures which would reduce available water for newly emerging seedlings, moisture for continual grass growth would be limited. Fairway crested wheatgrass proved the most successful competitor with alfalfa.

Cicer milkvetch showed a better grass/legume growth relationship. Fairway crested wheatgrass and slender wheatgrass illustrated good growth with the vetch. Hard fescue and russian wildrye also showed better growth. Western wheatgrass and indian ricegrass were not evident with the vetch. Grass growth along showed only slender wheatgrass and nordan crested wheatgrass.

Natural vegetation growth and invasion specifically wild rose, sandreed grass, blue grama and more minor amounts of other native species provided increasing competition for the vetch and grasses growing on the plot. Alfalfa competed very well with the native vegetation. The native species especially

sandreed grass (Calamovilfa longifolia) were more pronounced on the test site than the surrounding area. Such enhanced growth was quite certainly a fertilizer response. The legumes did not show any evidence of healty or abundant nodulation. The higher fertilizer applications probably inhibited nodulation activity.

4) Germination Test

All species germinated 100% within five days except western wheatgrass which germinated 90%. Western wheatgrass stayed at 90% germination.

CONCLUSIONS

The above results indicate that grasses should be seeded separately from alfalfa to compete successfully with this legume. An alternate row spacing of grass cross seeding at ninety degrees to alfalfa would probably produce more successful grass growth.

Grass seeding with cicer milkvetch produced more acceptable results even though the vetch showed less successful growth than alfalfa. The grasses grew more successfully with the vetch probably because of reduced legume competition. Cicer milkvetch is thus seen to be a viable legume to plant directly with grasses in a coarse textured soil in an arid climate.

To overcome feathery seeds and thus drill seeding problems, seeds such as sandreed grass and little blue stem would have to be coated to allow passage through a drill seeder.

ACKNOWLEDGEMENT

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